CLAIMS

1. A zoom lens used as a projection lens of a projector in which a prism is located between the projection lens and a spatial optical modulating element,

wherein a lens closest to the spatial optical modulating element is a meniscus positive lens whose convex surface faces a screen, and

a refractive index of the meniscus positive lens is 1.75 or more.

2. The zoom lens according to claim 1, wherein the following conditional expression (1) is satisfied:

$$(1) \quad -0.3 < (GLR1/GLnd - Bfw)/fw < -0.05$$

where GLR1 is a radius of curvature of a surface of the lens closest to the spatial optical modulating element, the surface facing the screen, GLnd is a refractive index at the d-line of the lens, Bfw is an air equivalent back focus of the zoom lens at a wide-angle end, and fw is a focal length of an entire zoom lens system at the wide-angle end.

3. The zoom lens according to claim 1, wherein the following conditional expression (2) is satisfied:

$$(2) \quad 5 < (GLR2 - Bfw)/fw$$

where GLR2 is a radius of curvature of a surface of the lens closest to the spatial optical modulating element, the surface facing the spatial optical modulating element, Bfw is an air equivalent back focus of the zoom lens at a wide-angle end, and fw is a focal length of an entire zoom lens system at the wide-angle end.

4. The zoom lens according to claim 1, wherein the following conditional expression (3) is satisfied:

(3) $2.5 < fGL/fw < 3.5$

where fGL is a focal length of the lens closest to the spatial optical modulating element, and fw is a focal length of an entire zoom lens system at the wide-angle end.

5. The zoom lens according to claim 1, wherein an Abbe number of the lens closest to the spatial optical modulating element is 30 or less.

6. The zoom lens according to claim 1, wherein the following conditional expression (4) is satisfied:

(4) $0.01 < PgFGL - 0.6457 + 0.0017 \times \nu dGL$

where PgFGL is a partial dispersion of the lens closest to the spatial optical modulating element, and νdGL is an Abbe number of the lens.

7. The zoom lens according to claim 1, wherein the following conditional expressions (5) and (6) are satisfied:

(5) $PgFGLn < 0.61$

(6) $(PgFGLn - PgFGL)/(\nu dGLn - \nu dGL) < -0.0027$

where PgFGLn is a partial dispersion of a negative lens closest to the spatial optical modulating element, $\nu dGLn$ is an Abbe number of the negative lens, PgFGL is a partial dispersion of the lens closest to the spatial optical

modulating element, and νdGL is an Abbe number of the lens.

8. The zoom lens according to claim 1, wherein the zoom lens has a first cemented surface, a second cemented surface, and a third cemented surface that are present in the indicated order from the screen side,

wherein the following conditional expressions (7) to (11) are satisfied:

(7) $6 < \nu dGp1 - \nu dGn1 < 12$

(8) $PgFGp1 - PgFGn1 < -0.02$

(9) $20 < \nu dGp2 - \nu dGn2 < 40$

(10) $|PgFGp2 - PgFGn2| < 0.007$

(11) $|PgFGp3 - PgFGn3| < 0.07$

where νdG1p is an Abbe number of a positive lens making up the first cemented surface, PgFG1p is a partial dispersion of the positive lens making up the first cemented surface, νdG1n is an Abbe number of a negative lens making up the first cemented surface, PgFG1n is a partial dispersion of the negative lens making up the first cemented surface, νdG2p is an Abbe number of a positive lens making up the second cemented surface, PgFG2p is a partial dispersion of the positive lens making up the second cemented surface, νdG2n is an Abbe number of a negative lens making up the second cemented surface, PgFG2n is a partial dispersion of the negative lens making up the second cemented surface, PgFG3p is a partial dispersion of a positive lens making up the third cemented surface, and PgFG3n is a partial dispersion of a negative lens making up the third cemented surface.

9. The zoom lens according to claim 8, wherein the Abbe number of the positive lens making up the second cemented surface is 90 or more.

10. The zoom lens according to claim 1, wherein the meniscus positive

lens whose convex surface faces the screen, a positive lens, and a positive lens are arranged in the indicated order in a direction from the spatial optical modulating element to the screen.

11. The zoom lens according to claim 1, comprising:

a first lens group having a negative refractive power;

a second lens group having a positive refractive power;

a third lens group having a positive refractive power;

a fourth lens group having a negative refractive power; and

a fifth lens group having a positive refractive power, arranged in the indicated order from the screen side,

wherein when zooming from a wide-angle end to a telephoto end, the second lens group, the third lens group, and the fourth lens group are moved toward the screen along an optical axis, while the first lens group and the fifth lens group are stationary,

wherein the third lens group is composed of a cemented lens consisting of a positive lens and a negative lens and a cemented lens consisting of a positive lens and a negative lens, arranged in the indicated order from the screen side, and

wherein the fourth lens group is composed of a biconcave negative lens, a cemented lens consisting of a biconcave negative lens and a biconvex positive lens, a positive lens, and a positive lens, arranged in the indicated order from the screen side.

12. The zoom lens according to claim 1, comprising:

a first lens group having a negative refractive power;

a second lens group having a positive refractive power;

a third lens group having a negative refractive power; and

a fourth lens group having a positive refractive power, arranged in the indicated order from the screen side,

wherein when zooming from a wide-angle end to a telephoto end, the second lens group and the third lens group are moved toward the screen along an optical axis, while the first lens group and the fourth lens group are stationary, and

wherein the first lens group is composed of an eleventh lens group having a negative refractive power and a twelfth lens group having a positive refractive power, arranged in the indicated order from the screen side, and a space between the eleventh lens group and the twelfth lens group is changed during focusing.

13. The zoom lens according to claim 12, wherein the twelfth lens group is composed of a meniscus positive lens whose convex surface faces the spatial optical modulating element.

14. The zoom lens according to claim 1, wherein the magnification of an entire zoom lens system ranges from 0.0023 times to 0.0188 times.

15. The zoom lens according to claim 1, wherein an F number at a wide-angle end is 1.7.

16. The zoom lens according to claim 1, wherein a zoom ratio is 1.3.

17. An image magnification projection system comprising:

a light source;

a spatial optical modulating element that is illuminated with light emitted from the light source and forms an optical image; and

a projection means for projecting the optical image formed on the spatial optical modulating element,

wherein the zoom lens according to any one of claims 1 to 16 is used as the projection means.

18. A video projector comprising:

a light source;

a means for temporally restricting light from the light source to three colors of blue, green and red;

a spatial optical modulating element that is illuminated with light emitted from the light source and forms optical images corresponding to the three colors of blue, green and red that are changed temporally; and

a projection means for projecting the optical images formed on the spatial optical modulating element,

wherein the zoom lens according to any one of claims 1 to 16 is used as the projection means.

19. A rear projector comprising:

the video projector according to claim 18;

a mirror for bending light projected by the projection means; and

a transmission-type screen for displaying an image of the light bent by the mirror.

20. A multi-vision system comprising:

a plurality of systems, each of which comprises the video projector according to claim 18, a transmission-type screen for displaying an image of light projected by the projection means, and a cabinet, and

an image dividing circuit for dividing an image signal, and sending the divided image signal to each of the video projectors.